AD 295 101

PROGRESS REPORT

ON

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"DESIGN CRITERIA FOR RADIATION RESISTANT

FLIGHT CONTROL SYSTEMS FOR AEROSPACE VEHICLES"

Period Covered: 1 May — 31 May 1962

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1. Technical Areas

The description of technical effort will be divided into the six major areas to facilitate presentation of accomplishments.

A. Determination of Flight Control Systems

A typical flight control system has been determined; this is outlined in the report NSL-62-90, "A Typical Flight Control System - Materials and Components". This report concludes 95% of the effort in this area. The remaining 5% concerns revisions.

B. Definition of Radiative Environment

The definition of the space radiative environment has been completed; this is presented in report NSL-62-80, "A Summary of the Natural Particulate Radiation in Space". The effort in this area is 90% complete; the remaining 10% represents minor revisions which will be made at a later date.

C. Determination of Radiation Penetration Through Satellite Walls

Progress has been made in the penetration calculation for both protons and electrons during this period. The various proton spectra to be considered are numerous and as defined in NSL-62-80 are not readily input into the proton shielding program described in NSL-62-81. The progress in handling the various proton spectra has been twofold. First, a polynominal least-squares program has been used to obtain an analytical expression for the Freden and White, Van Allen proton spectrum and secondly, an ancillary program has been prepared to punch fluxes for input energies when the differential flux spectrum is described by up to four expressions of the type $\varphi = AE^B$. These results facilitate preparing input for the proton shielding program.

It has been decided to use Lockheed's spectrum converter program (which has been checked out and run here at Northrop) to convert the solar flare integral proton spectra (Figure 33, NSL-62-80) to differential proton spectra. Presently, the polynominal least-squares program is being utilized to develop the analytical expressions of the integral spectrum to accurately obtain the large number of values desired as input for the spectrum converter.

During the period of this report a concentrated effort was made on the development of a bremsstrahlung program. Such a program has been written in FORTRAN for the IBM 7090 based on thin target theory because .040" (.274 gm/cm^2) aluminum does not stop all the incident electrons. This bremsstrahlung production program has been successfully run but found to need some minor corrections.

The effort in the area of penetration calculations has been broken into two divisions. The first effort will define typical spectra of protons, photons, and electrons impinging on components adjacent to the 0.040" aluminum skin for the four missions: 1) 2000 mile circular orbit, 2) 21,500 mile circular orbit, 3) 200 - 42,500 mile elliptical orbit, and 4) lunar probe. This effort will be completed during the next period, and a report describing this effort will accompany the 6th monthly progress report. The second effort will calculate the radiation energy absorbed by the flight control system components as a result of the impinging spectra defined in the first effort. It is anticipated that this second effort will be com pleted by approximately 15 September.

D. Determination of Radiation Damage Criteria

The discussion of radiation damage criteria and correlation feasibility has been broken down into two areas of consideration; these are 1) organics, and 2) semiconductor-type devices. Organics are damaged mainly through ionization processes; thus, damage will be directly related to the radiation energy absorbed by the material. The feasibility and limitations in using the "equal energy absorbed implies equal damage produced" concept has been under investigation. The energy absorbed by various organic materials listed in NSL-62-90 will be calculated using the penetration techniques described above. The devices (such as semiconductors) which will be damaged through displacement effects have presented a more severe problem concerning correlation. A feasible means of treating this problem has been investigated and will continue, based upon a breakdown into three levels:

1) a basic theoretical approach, which summarizes the calculations of such phenomena as number of displaced atoms, injection of impurities, etc., to compare these processes for the primary particles;

2) a semi-basic approach, which summarizes effects of neutrons and protons on characteristics such as diffusion lengths, minority carrier lifetimes, etc.;

3) a macroscopic approach, which summarizes the experimental data on proton, neutron, x-ray, and electron irradiation of devices and correlates on this level.

It is anticipated that the majority of the effort on correlation of organics will be completed by 15 August; the effort in this area is now approximately 25% complete.

E. Determination of Radiation Effects on Flight Control System

Damage thresholds for the typical flight control components and

materials listed in report NSL-62-90 have been partially determined. The specific listings will be used as a basis but thresholds will also be determined for other materials where they appear to be of interest. At the conclusion of the damage threshold determination the materials and components most susceptible to radiation damage will be identified for more intensive study. The results of the determination of damage thresholds, the calculation of radiation energy absorbed by the flight control system components, and organic correlation studies will be integrated to give a first approximation of radiation damage to organics by 15 September.

F. Test Program Analysis and Planning

The literature survey and assimilation of reference data on irradiation facilities and procedures was continued. The effort expended in this area is approximately 10% of the total effort contemplated.